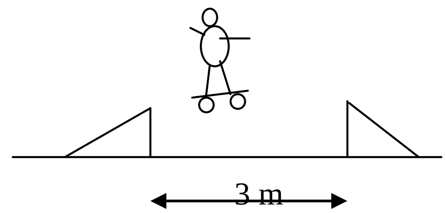
SPH4U Grade 12 Physics Final Exam
Practice Questions

Projectile Motion:

A cool, hip, skate boarding-type student attempts a fancy manoeuvre. She skates up a ramp, glides through the air and lands smoothly on a second ramp as shown below. Each ramp rises 1 m above the ground and has an angle of 45°. The ends of ramps are 3 m apart.

With what velocity should she leave the first ramp such that she lands smoothly on the second? (Note: Landing smoothly means that her velocity will be at the same angle as the second ramp. Hint: The magnitude of her starting and landing velocities will be the same.)



Circular Motion:

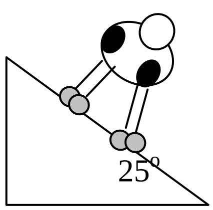
A 40.0 kg calf on a swing moves in a circular arc of radius 3.25 m. At the lowest position, the calf's speed reaches 2.75 m/s. Determine the magnitude of tension in each of the **two** vertical support chains when the swing is at its lowest position. (i.e. the 2 chains exert equal amounts of force on the swing)

Forces and Friction

A rope exerts a force of magnitude 750 N, at an angle 35° above the horizontal, on a cow at rest on a horizontal floor. The coefficients of friction between the cow and the floor are $\mu_s = 0.50$ and $\mu_k = 0.45$. The cow remains at rest. Draw a free body diagram and determine the smallest possible mass of the cow.

Forces and Circular Motion

A cow is rollerblading around a banked corner of radius 15 m that is inclined at an angle of 25°. The cow is moving at a constant speed and does not slide up or down the incline. Friction between the cow and incline are negligible. What is its speed? (Hint: the circular acceleration is towards the centre of the track, parallel to the ground, NOT parallel to the slope)



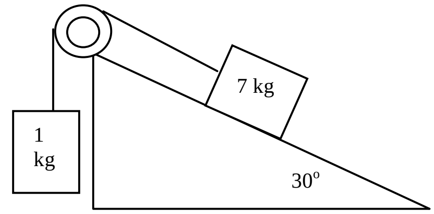
cow travelling out of page

Universal Gravitation and Circular Motion:

Astronomers have discovered a black hole near the star Cygnus-X. Normally a black hole is impossible to see, but the astronomer has noticed the star Cygnus-X orbiting around an invisible, but very massive object. Cygnus-X completes an orbit every 10 earth days. The radius of its orbit is 7.5×10^{11} m. Determine the mass of the black hole.

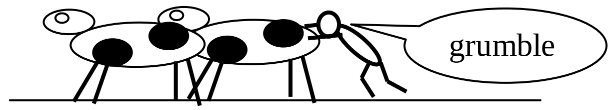
Forces and Friction

$\mu_k = 0.4$. Find the acceleration of the masses (if any)



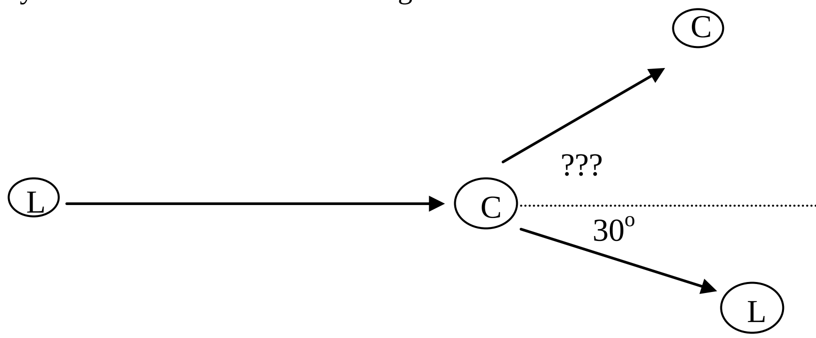
Newton's Laws, Applications of Forces

Sophie is trying to herd her cows. She finds two reluctant cows (400 kg each) standing in the field who do not want to move. The two cows are standing up against one another while Sophie is pushing with a mighty force of 3000 N. **Each** cow experiences a force of friction from the ground of 1400 N. Find the contact force between the two cows.



Collisions and Momentum

Curly was standing, minding his own business when along came Larry who bumped into him. The two went flying into a vat of glue and feathers. Larry, who has a mass of 80 kg, was moving with a velocity of 2.0 m/s when he bumped into Curly, who has a mass of 70 kg. Larry was deflected by an angle of 30^o, with a speed of 1.50 m/s. Determine the **velocity** of Curly after the collision. See the diagram below.



Special Relativity

You travel in a spacecraft from Earth to our closest neighbouring star, Proxima Centauri, which is 4.22 ly (light years) away. Your spacecraft travels at 0.9 c.

a) How much time does this take from Earth's frame of reference?
b) How much time does it take from your frame of reference?
c) What distance do you travel from your frame of reference?
d) What distance does an observer from Earth see you traveling?

Special Relativity

A cow (200 kg) is accidentally accelerated to 0.6 c. Determine the kinetic energy of the cow.

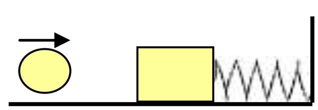
Gravitational Potential

After a dispute with his crew, Buzz Lightyear (100 kg) was kicked out of his ship and left floating in a **circular orbit** around the earth at an altitude of 4.0×10^6 m.

a) Determine his gravitational potential.
b) Determine his kinetic energy.
c) How much work must his rocket-pack do to boost him to an altitude of 8.0×10^6 m?
d) From his original orbit at the altitude of 4.0×10^6 m, how much work must his rocket-pack do to allow him to escape from the earth's gravity?

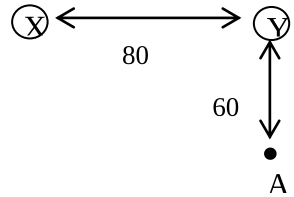
Collisions and Elastic Energy

A fuzzy Velcro ball of mass 200 g strikes and sticks to a Velcro block (100 g) that is attached to a spring. The block is initially at rest on a horizontal, frictionless surface. After impact the spring (k = 200 N/m) compresses by 8.0 cm. (a) What type of collision do the ball and block experience? (b) What was the initial velocity of the ball?



Fields

Determine the electric field **vector** experienced by a test particle at the point A, due to the two charges X (-2.5×10^{-5} C) and Y ($+3.9 \times 10^{-4}$C).



Fields

Two equally charged particles, held 3.2×10^{-3} m apart, are released from rest. The initial acceleration of the first particle is 7.0 m/s^2 and that of the second is 9.0 m/s^2. If the mass of the first particle is 6.3×10^{-7} kg, what are (a) the mass of the second particle, and (b) the amount of charge on each particle?

Fields

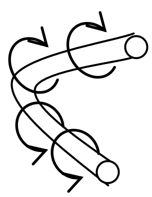
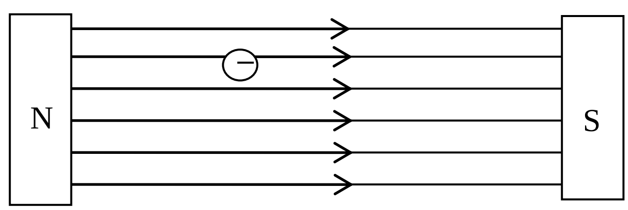
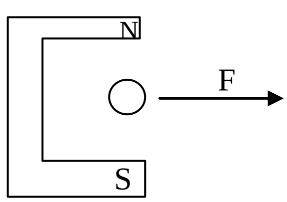
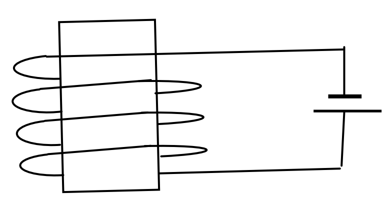
Beams of high-speed protons can be produced in “guns” using electric fields to accelerate protons. What acceleration would a proton experience if a gun’s electric field were 2.00×10^{4} N/C? ($m_{proton} = 1.67 \times 10^{-27}$ kg, $e = 1.60 \times 10^{-19}$ C)

Fields

An electron from a particle accelerator travels at 1.7×10^{5} m/s [E] through a strong magnetic field of 1.4×10^{3} T [S]. Determine the magnitude and direction of the **acceleration** of the electron. ($e = 1.60 \times 10^{-19}$ C, $m_{electron} = 9.1 \times 10^{-31}$ kg)

Fields

Complete the following diagrams by drawing conventional current direction, magnetic field lines, magnetic field polarity, or direction of force, where appropriate.

Current is flowing through a conductor. 	An electron is moving through a magnetic field (into the page) 
Current is flowing through a conductor. 	Current is flowing through the circuit. 

Fields

Light that is polarized in 1 direction is shone at filters set at 30° and then 75° to the light’s original direction of polarization. What is the **amplitude** of the transmitted electric field relative to the original field? What **intensity** of light gets through?

Equations and Values

$r_{earth} = 6.38 \times 10^6$ m

$r_{moon} = 1.74 \times 10^6$ m

$r_{moon\ orbit} = 3.84 \times 10^8$ m

$c = 3.00 \times 10^8\ {}^m\!/\!_s$

$G = 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$

$a_g = 9.80$ m/s^2

$m_{earth} = 5.98 \times 10^{24} kg$

$m_{moon} = 7.35 \times 10^{22} kg$

e = 1.60×10^{-19} C

k = 9.0×10^9 Nm^2/C^2

$m_{proton} = 1.67 \times 10^{-27} kg$

$m_{electron} = 9.11 \times 10^{-31} kg$

$F_g = \frac{GMm}{r^2}$

$E_g = -\frac{GMm}{r}$

$E_k = -\frac{1}{2} E_g$

$E_T = \frac{1}{2} E_g$

$v = \sqrt{\frac{GM}{r}}$

$\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$

$\vec{a}_{av} = \frac{\Delta \vec{v}}{\Delta t}$

$\Delta \vec{d} = \frac{(\vec{v}_1 + \vec{v}_2)}{2} \Delta t$

$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$

$\Delta \vec{d} = \vec{v}_1 \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$

$\Delta \vec{d} = \vec{v}_2 \Delta t - \frac{1}{2}\vec{a}(\Delta t)^2$

$\vec{v}_2^2 = \vec{v}_1^2 + 2\vec{a}\Delta d$

$a_c = \frac{v^2}{R} = 4\pi^2 R f^2 = \frac{4\pi^2 R}{T^2}$

$\vec{F}_{net} = m\vec{a}$

$\vec{F}_g = m\vec{g}$

$F_f = \mu F_n$

$\vec{p} = m\vec{v} = \vec{F}\Delta t$

$\vec{p}_t = \vec{p}_t'$

$W = F\Delta d \cos\theta$

$\vec{F} = -k\vec{x}$

$E_e = \frac{1}{2} k\vec{x}^2$

$E_k = \frac{1}{2} m\vec{v}^2$

$E_g = mg\Delta h$

$F_e = \frac{kq_1q_2}{r^2}$

$E_e = \frac{kq_1q_2}{r}$

$V = \frac{E_e}{q} = \frac{kq_1}{r}$

$\vec{\varepsilon} = \frac{\vec{F}_e}{q} = \frac{\Delta V}{r}$

$\vec{F}_{magnetic} = q\vec{v} \times \vec{B}$

$F_{magnetic} = qvB\sin\theta$

$\Delta t_m = \frac{\Delta t_s}{\sqrt{1 - \frac{v^2}{c^2}}}$

$L_s = \frac{L_m}{\sqrt{1 - \frac{v^2}{c^2}}}$

$E_{rest} = mc^2$

$E_{total} = \frac{mc^2}{\sqrt{1 - \frac{v^2}{c^2}}}$

$E_{total} = E_{rest} + E_k$